deviations was related to the beam energy, i.e. larger deviations were observed for the higher beam energy. The overall treatment time calculated with superposition was 5-7 % longer in comparison to the calculation of convolution, and the coverage of PTV, in terms of 95% isodose, was better (up to 18%). Hot spots were lower for superposition plans for both low and high energies.
Conclusions: Convolution algorithms are not adequate for dose calculations in the presence of and inside low density inhomogeneities, while the superposition algorithm showed better agreement for all cases.Convolution algorithm overestimates the delivered dose, which leads to the underdosage of the target volume in reality. This applies both to lower energy and even more to higher energy beams. Differences between doses calculated with superposition and convolution algorithms are primarily due to changes in electron transport in the lungs, which is not adequately taken into account by convolution algorithm. Following these findings, and recommendations from the literature all lung patients is planned with superposition algorithm.
Acknowledgement: The work has been supported by IAEA through the national SRB6006 and regional RER 6023 technical cooperation project.

EP-1215

The effect of photon energy on the intensity-modulated radiation therapy (IMRT) plans for prostate cancer

E. Kara[1], B. Dirican[2], A. Yazici[1]
[1]*Onko Ankara Oncology center, Oncology Department, Ankara, Turkey*
[2]*Gülhane Military Hospital, Oncology Department, Ankara, Turkey*

Purpose/Objective: To evaluate the effect of 6, 15 MV and mixed energy (6&15MV) on intensity-modulated radiation therapy (IMRT) plans for prostate cancer using the equivalent uniform dose (EUD) and normal tissue complication probability (NTCP).
Materials and Methods: In this study, immobilization and CT simulation were performed for 15 prostate cancer patients, as is routine for prostate cancer patients receiving IMRT in our department. The treatment position is supine with kneefix. Using the simulator lasers, patients were aligned and marked to define the coordinate system to be used for treatment planning. The patients were scanned in treatment position on Siemens Emotion Duo using 5-mm slice thickness. The data transferred to the treatment planning system. The determination of the 15 prostate cancer patient's target volume and critical tissues are initially done by using CT images obtained in our clinic. After definition of the critical organs which are rectum, bladder and femoral heads, three different IMRT plans were done for each of 15 patients using 6 MV, 15 MV and mixed 6 and 15 MV energies using similar dose constraints and 8-fields setting. Gantry angles of 225°,260°, 295°, 330°, 65°, 100°and 135° are used in our clinic for IMRT plans for prostate cancer. For the plan of mixed-energy, 15 MV photon beams at the gantry angles of 100°and 260° were used while 6 MV were used for the rest of the gantry angles.The dose distributions were similar for all plannings. Three plans were evaluated and compared by using EUD and NTCP.
Results: For the bladder, rectum and both right and left femoral heads, the NTCP values were calculated less than %1 for the plannings with 6 MV, 15 MV and mixed energy plans. However, NTCP values to the bladder and rectum of mixed-energy plans were slightly lower than that of 6 MV and 15 MV plans.
Conclusions: The study does not show any significant differences between plannings with 6 MV, 15 MV and mixed energies with respect to NTCP. Also there is no significant difference in the dose distribution. However, the results of this study show that by using mixed-energy in aprostate IMRT plan, the bladder and rectum doses can be slightly reduced and the plan quality can be improved.

EP-1216

Prostate IMRT: dosimetric comparison between a clinical trial and clinical practice

G. Delpon[1], C. LLagostera[1], S. Supiot[2], A. Lisbona[1], S. Chiavassa[1]
[1]*ICO, Medical Physics, Nantes, France*
[2]*ICO, Radiotherapy, Nantes, France*

Purpose/Objective: Due to the complexity of the IMRT dose distributions, a modification in the clinical practice such as contour definition or prescription may have a dosimetric impact and has to be evaluated. This situation occurs for some clinical trials. This study aimed at comparing dose distributions obtained for two groups of patients representative of clinical practice and a particular clinical trial.
Materials and Methods: In our clinical practice, cancer prostate radiotherapy treatments consist in delivering 76Gy/38 fractions using IMRT. The following dosimetric objectives are considered for plan validation: PTV (D95%>95%), bladder wall (V65Gy<25%, V40Gy<50%), rectal wall (V70Gy<15%, V65Gy<25%, V38Gy<50%), and femoral heads (V50Gy<10%, V30Gy<50%). For a clinical trial, a new definition of contours and a new prescription were defined. Prescription was 78Gy/39 fractions with the following dosimetric objectives: CTV (D99%>78Gy), PTV (D95%>74.1Gy, D1cc<81.9Gy), bladder and rectal walls (D30%<72.8Gy, D50%<54.3Gy), femoral heads (D5%<54.3Gy). 30 patient treated between 2006 and 2012 were randomly selected from our database to create a control group. Mean number of MUs and homogeneity index ((D2%-D98%)/D50%) were calculated. For organs at risk, organs were delineated according to the clinical practice, and dose volume histogram values were reported. For the five first patients included in the clinical trial, contours and plans were validated following protocol recommendations. However, contours were also defined according to the clinical practice. For example, the bladder was contoured either only 18mm above the base of the prostate and in totality for clinical trial and clinical practice, respectively. For these 5 patients, usual dose volume histogram values were reported and compared to the control group.
Results: Homogeneity indices were 0.05±0.01 and 0.10±0.02 for CTV and PTV respectively for the control group. They were slightly better for the study group: 0.04±0.01 and 0.07±0.01. These results showed a satisfactory target volume coverage whatever the protocol. Compared to the control group, number of MUs was 8% higher for the study group. For the bladder, the dose histogram values were reported as a function of the percentage of the overlap between the bladder and the PTV. Results obtained for the control group showed a very good reproducibility and robustness of IMRT prostate planning procedures. Values reported for the study group were similar to the control group despite the higher dose prescribed to the target volume. Similar results were obtained for rectum and femoral heads.
Conclusions: This study showed that the clinical trial protocol led to dosimetric results similar to those obtained in our clinical practice despite the differences in contours and prescriptions. Physicians were therefore more confident to include patients in the clinical trial.

EP-1217

Comparison of volumetric modulated arc therapy and intensity modulated radiotherapy for pelvic malignancies

S. Das Majumdar[1], J. Kunnanchath[1], G. Tharmarnadar[2], S. Devadason[2], S. surendran[3], J. Madhavan[3], G. Shirley[3]
[1]*Salmaniya Medical Complex, Radiation Oncology, Manama, Bahrain*
[2]*Karunya University, Physics, Coimbatore, India*
[3]*KIMS Pinnacle Cancer Center, Oncology, Trivandrum, India*

Purpose/Objective: This study was performedto examine the potential role of volumetric modulated arc therapy (VMAT) in comparison with intensity modulated radiotherapy (IMRT) for pelvic malignancies.
Materials and Methods: Seven field dynamic IMRT and double arc VMAT plans were compared for ten pelvic cancer cases in terms of total monitoring units (MU), maximum dose, conformity index, uniformity or homogeneity index, integral dose and dose to normal structures. All the plans were created in eclipse version10 treatment planning system (TPS) and executed in Varian Clinax-iX linear accelerator through ARIA10 networking platform. Student's paired t-test was performed to compare the results.
Results: Average conformity index of IMRTplan was 1.5+/1 0.12, but the VMAT plans achieved on an average of 1.38±0.04(p-value of 0.016). Average uniformity index for VMAT plan was 1.05±0.01, but in IMRT it was 1.074±0.02 (p-value of 0.006). No significant difference was observed in maximum dose between IMRT and VMAT (p-value of 0.854). The integral dose (p-value of 0.003) and normal tissues dose was found less in VMAT plans compared to IMRT plans. The average MU needed to deliver the dose of 200 cGy per fraction was 415±33 for VMAT plans, while for IMRT plan it was 743±92(p-value of 0.000). VMAT plans involve two full rotation of gantry, so that it gives more freedom in dose modulation. In VMAT, image guidance improves tumour targeting and the fast delivery in less than 2-5 minutes helps to minimise the probability of intra fractional movement of target and critical organs. The reduction in treatment time gives more comfort and less stress to patients. Significant reduction of MU in VMATplans compared to IMRT may result in less leakage and scattered radiation and low overall peripheral dose.
Conclusions: The comparative study with VMAT versus IMRT employed in pelvic cancers proved, better normal tissues sparing and better target coverage by VMATcompared to IMRT technique.

EP-1218

Quality of radiation treatment planning in postmastectomy patients- comparison of 3D versus 2D plans

K. Antunac[1], V. Rajevac[1], M. Solak Mekic[1], H. Sobat[1]
[1]*University Hospital for Tumors CHC "Sisters of Charity", Radiation Oncology Dpt., Zagreb, Croatia*

Purpose/Objective: To compare the quality of 3D versus 2D planning in postmastectomy patients in terms of target volume coverage and sparing of organs at risk.
Materials and Methods: 27 postmastectomy patients, 16 with left and 11 with right sided breast cancer. Clinical target volume was chest wall and supraclavicular fossa ± axilla. PTV1a consisted of chest wall, up to skin surface and PTV1b consisted of supraclavicular fossa ± axilla plus 1 cm margin; distance from skin surface was 0,5 cm. Deliniated organs at risk were both lungs, spinal cord and heart for left sided breast cancer. Total dose was 50 Gy in 25 fractions. For each patient 2 plans were made: 3D and 2D plan. For 3D plan forward IMRT planning technique was used. Tangential fields were used for PTV1a and AP-PA opposed fields for PTV1b, all with 6MV photons. 2D plan was made using direct electron field (energy 9-12 MeV, depending on chest wallthickness) on PTV1a and combination of direct electron field (18 Mev) and direct photon field (6 MV) on PTV1b. For PTV1a bolus of 0,5 cm was used. For 3D plans required PTV coverage with 95-107% of prescribed dose was at least 85%. Dose constraints for OAR were V20Gy< 35% for lung, D_{max} <45 Gy for spinal cord and V20Gy< 10% and V40Gy< 5% for heart. Patients were placed on Med-Tec MT-350 with both hands above head, head in forward position. For planning XIO 4.3.1 and 4.6.4 with fast-superposition and superposition algorhytm respectably for the photon beam calculation were used. Electron fields were calculated with pencil beam algorhytm. The CT slice thickness and calculation resolution of 0,2 cm was used. Statistical method: student t-test.
Results

	Coverage PTV1a (%)	Coverage PTV1b (%)	D_{max} (Gy)	Lung L V20Gy (%)	Lung L MD (Gy)	Lung R V20Gy (%)	Lung R MD (Gy)	Heart V20Gy (%)	Heart V40Gy (%)	Heart MD (Gy)	Spinal cord D_{max} (Gy)
Left sided											
3D	88.8 (3.5)*	90.4 (3.9)	53.5 (0.2)	31.9 (6.3)	16.2 (2.7)	0.35 (0.88)	0.67 (0.49)	7.6 (1.9)	3.5 (1.1)	5.0 (1.2)	36. (9.6)
2D	83.1 (7.2)	61.2 (16.2)	73.5 (3.3)	31.0 (13.3)	15.2 (5.4)	0.85 (1.39)	1.98 (0.98)	5.3 (3.5)	0.4 (0.5)	5.6 (1.9)	33.2 (6.2)
p-value	<0.01	$<10^{-6}$	$<10^{-6}$	NS**	NS	NS	$<10^{-4}$	<0.03	$<10^{-6}$	NS	NS
Right sided											
3D	91.2 (3.2)	89.5 (2.0)	53.6 (0.2)	0.06 (0.1)	0.4 (0.1)	34.2 (2.0)	17.0 (1.3)				39.7 (5.8)
2D	82.4 (6.4)	51.7 (19.3)	74.4 (2.2)	0.25 (0.4)	2.2 (0.8)	28.6 (9.6)	14.8 (4.2)				34.1 (4.6)
p-value	<0.01	$<10^{-5}$	$<10^{-6}$	$<10^{-6}$	NS	NS	NS				<0,03

* median and standard deviation, ** not significant
Statistically significant difference for left-sided breast cancer was observed in PTV1a and PTV1b coverage, MD on right lung, V20Gy and V40Gy on heart and D_{max}. For right-sided breast cancer statistically significant difference was observed in PTV1a and PTV1b coverage, V20Gy on left lung, D_{max} on spinal cord and D_{max}.
Conclusions: 3D planning provided significantly better PTV coverage and lower maximal doses, but without significant influence on doses on OAR (lungs and spinal cord) when compared to 2D planning. Nevertheless, higher doses on heart were observed with 3D planning, but within dose constraints.

EP-1219

Planning study of locally advanced ethmoid sinus cancer patient.

H. Tanaka[1], K. Nihei[1], S. Kitou[1], S. Kageyama[1], T. Mitsuhashi[1], K. Karasawa[1]
[1]*Tokyo Metropolitan Cancer and Infectious Diseases Center Komagome Hospital, Radiation Oncology, Tokyo, Japan*

Purpose/Objective: The aim of this study is to compare the dose distributions of intensity-modulated radiotherapy (IMRT) plans and accuracy of patient setting between MHI TM-2000 (VERO), TomoTherapy HiArt System (TomoTherapy), and conventional linac (Clinac 21EX), all of which are installed in our institution.
Materials and Methods: One patient with locally advanced ethmoid sinus cancer (T4aN0M0) treated by IMRT at our institution was evaluated in this planning study. The clinical target volume (CTV) was defined as gross tumor volume and right side nasal and paranasal sinus. The planning targetvolume (PTV) was defined as the CTV + three-dimensional margins of 5 mm. IMRT planning was implemented for 3 different treatment machines, including VERO,TomoTherapy, and Clinac 21EX, so as to achieve the similar optimal dose delivery to the target volumes with the same dose constraints for normal tissues. IMRT schedule consisted of 70Gy in 35fr. As the method of IMRT, segmental multi-leaf collimator (MLC) IMRT with 9 static ports, helical IMRT, and dynamic MLC IMRT with 9 static ports (2 non-coplaner ports and 7 coplaner ports), were adopted for VERO, TomoTherapy, and Clinic 21EX, respectively. As planning software, iPlan ver.4.5.1, TomoTherapy Planning Station 4.1.2, and Eclipse ver.10.0 were used for VERO, TomoTherapy, and Clinac 21EX, respectively. The dose-volume parameters described below were calculated in each treatment machine: D2, D50 and D95 of the PTV and CTV; D2 of the optic nerves, chiasm, and eye balls; average dose of the Brain. As Modality of image guidance, Cone beam CT (KvCT), Cone beam CT (MvCT), and 2D EPID were used for VERO, TomoTherapy, and Clinac 21EX, respectively.
Results: The dose-volume parameters calculated in each treatment machine are shown in the table.

		tomotherapy	varian−pinnacle	vero−iplan
GTV	D95(Gy)	63.4	69.8	68.6
	D50(Gy)	72.6	72.9	73.1
	D2(Gy)	75.9	76.2	75.1
CTV	D95(Gy)	63.8	69.1	68.1
	D50(Gy)	72.3	72.9	73.1
	D2(Gy)	76.0	75.8	75.4
PTV	D95(Gy)	61.6	63.8	58.9
	D50(Gy)	72.5	72.5	72.5
	D2(Gy)	76.2	76.4	75.2
Lt optic nerve	D2(Gy)	48.3	43.7	52.3
Rt optic nerve	D2(Gy)	48.6	49.3	50.1
chiasm	D2(Gy)	48.5	48.0	51.0
Brain stem	D2(Gy)	40.0	43.4	33.7
Brain	average(Gy)	14.4	16.2	10.7
Lt eye ball	D2(Gy)	31.8	19.8	34.1
	average(Gy)	22.6	9.0	17.8
Rt eye ball	D2(Gy)	54.4	49.1	44.0
	Average(Gy)	31.4	20.9	37.8

Conclusions: The target volume coverage and the normal tissue doses in patients with locally advanced ethmoid sinus cancer were compared between the 3 treatment plans, using VERO, TomoTherapy, and Clinac 21EX. All plans achieved acceptable dose delivery, but plan of Clinac 21EX with 2D EPID may not achieve enough accuracy of patient setting.

EP-1220

Contouring need for RT immobilization and repositioning systems

A. Fidanzio[1], L. Placidi[1], G. D'Agostino[2], G. Mattiucci[2], D. Pasini[2], A. Piermattei[2]
[1]*UCSC, Medical Physics, Roma, Italy*
[2]*UCSC, Radiotherapy, Roma, Italy*

Purpose/Objective: The beam attenuation impact on the planed dose distribution, due to the immobilization and repositioning systems (IRSs) used in radiotherapy, was studied to evaluate the need of IRS contouring.
Materials and Methods: Three IRSs were selected for this study. In particular an uni-frame with PMMA support (UFP) (Tema Sinergie) was tested for 3DCRT 6 MV treatments, an uni-frame with carbon support (UFC) (Civco) was tested for head and neck IMTR 6 MV treatments and a Body Fix (BF) (3D Line) was tested for stereobody 6 and 15 MV treatments. The beam attenuation, when the beam axis intercepts the IRSs, was measured for 6 MV and 15 MV photon beams by ion-chamber and simulated by Eclipse (Varian) TPS to assess the TPS accuracy in modelling the IRS. Then 10 patients for each IRS were selected and two treatment plans were performed for each patient, with and without IRS contouring. The two plans were compared using dose volume histograms (DVH) and in particular evaluating the average dose to target variations. A method of transit in-vivo dosimetry (IVD) by EPID was adopted to verify that the IRS contouring was performed and gave the expected results in clinical routine.
Results: The percentage of attenuations measured by ion-chamber for 6 and 15 MV beams were 8.0% and 4.5% for UFP, 5.0% and 3.5% for UFC and 3% and 2% for BF respectively. These data were well reproduced by the TPS within ±1%. The mean percentage target dose variations obtained comparing the IRS contoured and not countered plans and averaged over the ten selected patients were 2.9 %, 1.1 % and 1.3 % for UFP, UFC and BF respectively. While the maximum percentage target dose variations were 6.5 %, 2.8 % and 2.5 % for UFP, UFC and BF respectively. IVD for patients with contoured IRS, performed in